

a3  
cont the excitation vector;  $\delta$  is the regularization parameter that prevents division by zero;  $|e_n|$  is the mean error; and  $\{e_n\}$  is a sample of echo signal.

15. (Amended) A robust echo canceller comprising:

an adaptive filter for outputting an error signal in response to a detected echo signal; and

means for supplying adaptive filter coefficients to said filter, wherein said

a4 filter coefficients are given by the formula:  $h_{n+1} = h_n + \mu G_n X_n R_{xx}^{-1}(n) [\varphi(|e_n|) \circ \text{sign}(e_n)]$ , wherein  $h_n$  is the estimated echo path;  $\mu$  is the overall step size parameter;  $G_n$  is the step-size matrix;  $X_n$  is the excitation matrix;  $R_{xx}^{-1}$  is the correlation matrix;  $|e_n|$  is the mean error;  $\circ$  denotes elementwise multiplications; and  $\{e_n\}$  is a sample of echo signal..

#### REMARKS

This Amendment is being filed in response to an Office Action mailed on May 9, 2002. Applicants respectfully request reconsideration of the present application in light of the amendments and remarks set forth herein.

Claims 1-16 are currently pending in the present application. By this Amendment, applicants have amended the claims and specification, specifically, applicants have corrected a typographical error in the specification, and amended claims 7-10, 13 and 15. Applicants submit that no new matter is added by the amendments to the specification and claims set forth herein.

In the Office Action, the Examiner has objected to the specification due to a certain typographical error. Accordingly, the Applicants have amended the specification to correct the

typographical error cited by the Examiner. The Applicants submit that no new matter is added by the amendment to the specification.

In the Office Action, the Examiner has objected to claims 7-10, 13 and 15 due to informalities. The Examiner asserts that the formulas in claims 7-10, 13 and 15 should have notations in order to clarify the invention. The Applicants have accepted the Examiner's recommendation and have amended claims 7-10, 13 and 15 by inserting notations in claims 7-10, 13 and 15. Applicants assert that no new matter is added by the amendments to the claims set forth herein.

The Examiner has stated that this application is being examined under 35 U.S.C. §102(e) prior to the Amendment by the AIPA (pre-AIPA 35 U.S.C. § 102(e)) due to the pre-AIPA filing date of the application of January 6, 1999.

The Examiner has rejected claims 1-2 and 11-12 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,185,300 to Romesburg ("Romesburg"). More specifically, regarding claim 1, the Examiner asserts that Romesburg teaches a robust adaptive filter (430; See Col. 16, lines 44-60; See Fig. 4, and respective portions of the specification), comprising:

a fast impulse response filter (450; See Col. 12, lines 14-33);

a coefficient vector update device (455) connected to the fast impulse response filter for feeding adaptive coefficients thereto in response to a received error signal (See Col. 13, lines 26-57); and

a modifying device for modifying the adaptive coefficients by application of an adaptive scaled non-linearity (i.e., NLP, See MATLAB script in Col. 21-22).

Applicants respectfully traverse the rejection of claim 1. Applicants respectfully submit that Romesburg neither teaches or suggests Applicants' invention, as recited by the claims presently in the application. Romesburg teaches the non-linear post processing ("at the end of a block of samples") of the residual echo in order to remove it from the system. According to the teachings of Romesburg, in other words, Romesburg teaches the application of update coefficients not continuously, but rather at the end of a block of samples (See Col. 12, lines 14-18). Nor does Romesburg disclose the use of an adaptive scaled non-linearity in the feedback path to the adaptive filter. In other words, Romesburg teaches the removal of residual echo at the end of a block of samples. Conversely, Applicants' invention discloses an adaptive scaled non-linearity applied to the residual error that is fed back to the update equation.

In the Office Action, the Examiner has identified the MATLAB script in Col. 21-22 to support his position that Applicants' invention is anticipated by Romesburg. Applicants respectfully disagree with the Examiner and take this opportunity to point out certain differences between their inventions and the teachings provided by Romesburg. The MATLAB script in Col. 21-22 teaches the use of non-linear processing (NLP). NLP is then used to apply adaptive coefficients at the end of a sample block to filter out echo in the signal. Conversely, Applicants' invention discloses the application of an adaptive scaled non-linearity to modify the adaptive coefficients to filter the residual error that is fed back to the update equation.

Applicants respectfully submit that Romesburg does not disclose the use of an adaptive scaled non-linearity for modifying the adaptive coefficients, as recited by Applicants' claim 1. Rather, Romesburg's teaching of the removal of residual echo using non-linear processing at the

end of a sample block in fact teaches away from such an invention. Thus, applicants respectfully submit that Romesburg neither teaches nor suggests the present invention as recited by claim 1.

Applicants thus respectfully submit that the instant invention, as recited by claim 1, is patentably distinguishable over Romesburg. Applicants further respectfully submit that the invention recited by claim 1 is not anticipated by Romesburg, as that reference fails to teach or suggest each element recited by those claims, as is required of a proper 35 U.S.C. § 102(e) reference. See, e.g., MPEP § 706.02. Finally, applicants respectfully submit that the Examiner's rejection of claim 1 as anticipated by Romesburg is no longer tenable, and respectfully request withdrawal of that rejection. Applicants further respectfully submit that the invention recited by claim 1 is not rendered obvious by any proposed hypothetical combination of Romesburg and any other prior art of record or with the knowledge of a person of ordinary skill in the art.

The Examiner has rejected claim 2 under 35 U.S.C. §102(e) as being anticipated by Romesburg. Applicants respectfully traverse that rejection. Applicants respectfully submit that Romesburg neither teaches or suggests Applicants' invention, as recited. Applicants reassert the same argument as presented above with regard to claim 1. Namely, that Romesburg teaches the use of applying non-linear processing at the end of a sample block to modify the adaptive coefficients, whereas, applicants' invention in the present application discloses the use of an adaptive scaled non-linearity for modifying the adaptive coefficients. Thus, applicants respectfully submit that Romesburg neither teaches nor suggests the present invention as recited by claim 2.

Applicants thus respectfully submit that the instant invention, as recited by claim 2, is patentably distinguishable over Romesburg. Applicants further respectfully submit that the

invention recited by claim 2 is not anticipated by Romesburg, as that reference fails to teach or suggest each element recited by those claims, as is required of a proper 35 U.S.C. § 102(e) reference. See, e.g., MPEP § 706.02. Finally, applicants respectfully submit that the Examiner's rejection of claim 2 as anticipated by Romesburg is no longer tenable, and respectfully request withdrawal of that rejection. Applicants further respectfully submit that the invention recited by claim 2 is not rendered obvious by any proposed hypothetical combination of Romesburg and any other prior art of record or with the knowledge of a person of ordinary skill in the art.

The Examiner has rejected claim 11 under 35 U.S.C. §102(e) as anticipated by Romesburg. Applicants respectfully traverse that rejection. Applicants assert that Romesburg teaches the use of applying non-linear processing at the end of a sample block to modify the adaptive coefficients, whereas, applicants' invention in the present application discloses the use of an adaptive scaled non-linearity for modifying the adaptive coefficients. Thus, applicants respectfully submit that Romesburg neither teaches nor suggests the present invention as recited by claim 11.

Applicants thus respectfully submit that the instant invention, as recited by claim 11, is patentably distinguishable over Romesburg. Applicants further respectfully submit that the invention recited by claim 11 is not anticipated by Romesburg, as that reference fails to teach or suggest each element recited by those claims, as is required of a proper 35 U.S.C. § 102(e) reference. See, e.g., MPEP § 706.02. Finally, applicants respectfully submit that the Examiner's rejection of claim 11 as anticipated by Romesburg is no longer tenable, and respectfully request withdrawal of that rejection. Applicants further respectfully submit that the invention recited by

claim 11 is not rendered obvious by any proposed hypothetical combination of Romesburg and any other prior art of record or with the knowledge of a person of ordinary skill in the art.

The Examiner has rejected claim 12 under 35 U.S.C. §102(e) as anticipated by Romesburg. Applicants respectfully traverse that rejection. Applicants respectfully submit that Romesburg neither teaches nor suggests applicants' invention as recited. In the present application, claim 12 depends from claim 11. Consequently, the rejection of claim 12 should be withdrawn by the Examiner because claim 12 depends from an allowable claim. Thus, applicants respectfully submit that Romesburg neither teaches nor suggests the present invention as recited by claim 12.

Applicants thus respectfully submit that the instant invention, as recited by claim 12, is patentably distinguishable over Romesburg. Applicants further respectfully submit that the invention recited by claim 12 is not anticipated by Romesburg, as that reference fails to teach or suggest each element recited by those claims, as is required of a proper 35 U.S.C. § 102(e) reference. See, e.g., MPEP § 706.02. Finally, applicants respectfully submit that the Examiner's rejection of claim 12 as anticipated by Romesburg is no longer tenable, and respectfully request withdrawal of that rejection. Applicants further respectfully submit that the invention recited by claim 12 is not rendered obvious by any proposed hypothetical combination of Romesburg and any other prior art of record or with the knowledge of a person of ordinary skill in the art.

The Examiner has rejected claims 3 and 4 under 35 U.S.C. §103(a) as being unpatentable over Romesburg in view of U.S. Patent No. 5,951,626 to Duttweiler. Applicants respectfully traverse that rejection. In the first instance, there is no teaching or suggestion in the references to make the hypothetical combination proposed by the Examiner, and thus the combination is

improper. Applicants further respectfully traverse the cited hypothetical combination of references on grounds that these combinations involve impermissible hindsight reconstruction of the invention involving "picking and choosing" from the teachings of that art. "Care must be taken to avoid hindsight reconstruction by using the application as a guide through the maze of prior art references combining the right references in the right way so as to achieve the result of the claims in suit." Grain Processing Corp. v. American Maize-Products Co., 840 F.2d 902, 907 (Fed. Cir. 1988).

In addition to the arguments set forth above with respect to Romesburg, Duttweiler only teaches an adaptive filter that the fast converging algorithm is PNLMS, in order to distribute adaptive energy evenly across the tap. Duttweiler does not teach an adaptive scaled non-linearity for modifying the adaptive coefficients. Further, the shortcomings of Romesburg, as set forth in detail above, are in no way overcome by the disclosure of Duttweiler. Thus, applicants respectfully submit that the invention recited by claims 3 and 4 is not rendered obvious by the Examiner's proposed combination of Romesburg and Duttweiler, and applicants respectfully request withdrawal of that rejection.

The Examiner has rejected claim 5 under 35 U.S.C. 103(a) as being unpatentable over Romesburg in view of U.S. Patent No. 5,428,562, to Gay. Applicants respectfully traverse that rejection. In the first instance, there is no teaching or suggestion in the references to make the hypothetical combination proposed by the Examiner, and thus the combination is improper. Applicants further respectfully traverse the cited hypothetical combination of references on grounds that these combinations involve impermissible hindsight reconstruction of the invention involving "picking and choosing" from the teachings of that art. "Care must be taken to avoid

hindsight reconstruction by using the application as a guide through the maze of prior art references combining the right references in the right way so as to achieve the result of the claims in suit." Grain Processing Corp. v. American Maize-Products Co., 840 F.2d 902, 907 (Fed. Cir. 1988).

In addition to the arguments set forth above with respect to Romesburg, Gay only teaches an adaptive filter that the fast converging algorithm is APA (see col. 2, lines 53-65) in order to achieve fast convergence through sample-by-sample updating with low complexity (see col. 1, lines 46-47). Gay does not teach an adaptive scaled non-linearity for modifying the adaptive coefficients. Further, the shortcomings of Romesburg, as set forth in detail above, are in no way overcome by the disclosure of Gay. Thus, applicants respectfully submit that the invention recited by claim 5 is not rendered obvious by the Examiner's proposed combination of Romesburg and Gay, and applicants respectfully request withdrawal of that rejection.

The Examiner has rejected claim 6 under 35 U.S.C. §103(a) as being unpatentable over Romesburg in view of U.S. Patent No. 6,137,881, to Oh et al. Applicants respectfully traverse that rejection. In the first instance, there is no teaching or suggestion in the references to make the hypothetical combination proposed by the Examiner, and thus the combination is improper. Applicants further respectfully traverse the cited hypothetical combination of references on grounds that these combinations involve impermissible hindsight reconstruction of the invention involving "picking and choosing" from the teachings of that art. "Care must be taken to avoid hindsight reconstruction by using the application as a guide through the maze of prior art references combining the right references in the right way so as to achieve the result of the



claims in suit." Grain Processing Corp. v. American Maize-Products Co., 840 F.2d 902, 907 (Fed. Cir. 1988).

In addition to the arguments set forth above with respect to Romesburg, Oh merely teaches an adaptive filter wherein the fast converging algorithm is PAPA (see col. 2, line 47-col. 3, line 17) in order to improve the numerical stability of the filter algorithm (see col. 1, lines 48-49). Oh does not teach an adaptive scaled non-linearity for modifying the adaptive coefficients. Further, the shortcomings of Romesburg, as set forth in detail above, are in no way overcome by the disclosure of Oh. Thus, applicants respectfully submit that the invention recited by claim 6 is not rendered obvious by the Examiner's proposed combination of Romesburg and Oh, and applicants respectfully request withdrawal of that rejection.

The Examiner has rejected claims 7-8 and 9-10 under 35 U.S.C. 103(a) as being unpatentable over Romesburg in view of Duttweiler further in view of U.S. Patent No. 5,790,440, to Fujii et al, and further in view of Kim and Efron ("Adaptive Robust Impulse Noise Filtering," IEEE Transaction on Signal Processing, Vol. 43, No. 8, pp. 1855-1866, August 1995). Applicants respectfully traverse that rejection. In the first instance, there is no teaching or suggestion in the references to make the hypothetical four-reference combination proposed by the Examiner, and thus the combination is improper. Applicants further respectfully traverse the cited hypothetical combination of references on grounds that these combinations involve impermissible hindsight reconstruction of the invention involving "picking and choosing" from the teachings of that art. "Care must be taken to avoid hindsight reconstruction by using the application as a guide through the maze of prior art references combining the right references in the right way so as to achieve

the result of the claims in suit." Grain Processing Corp. v. American Maize-Products Co., 840 F.2d 902, 907 (Fed. Cir. 1988).

In addition to the arguments set forth above with respect to Romesburg and Duttweiler, Fujii fails to teach an adaptive scaled non-linearity for modifying the adaptive coefficients. Applicants agree that Fujii does teach the use of a sign function. However, the sign function of Fujii is not scaled. Further, the shortcomings of Romesburg, as set forth in detail above, are in no way overcome by the disclosures of Duttweiler and/or Fujii. Moreover, in addition to the arguments set forth above with respect to Romesburg, Duttweiler and Fujii, Kim and Efron fail to teach an adaptive scaled non-linearity for modifying the adaptive coefficients. Further, the shortcomings of Romesburg, Duttweiler and Fujii as set forth in detail above, are in no way overcome by the disclosure of Kim and Efron. Thus, applicants respectfully submit that the invention recited by claims 7-8 and 9-10 is not rendered obvious by the Examiner's proposed combination of Romesburg, Kim and Efron, Duttweiler, and Fujii, and applicants respectfully request withdrawal of that rejection.

The Examiner has rejected claim 13 under 35 U.S.C. 103(a) as being unpatentable over Romesburg in view of Oh, Linebarger, Priest, and Raghothaman ("A Fast Affine Projection Algorithm for an Acoustic Echo Canceller using a Fixed-Point DSP Processor," ICASSP IEEE Int. Conf. Acoustics, Speech, and Signal Processing, 1997, pp. 4121-4124), further in view of Fujii and further in view of Kim and Efron. Applicants respectfully traverse that rejection. In the first instance, there is no teaching or suggestion in the references to make the hypothetical combination proposed by the Examiner, and thus the combination is improper. Applicants further respectfully traverse the cited hypothetical combination of references on grounds that

these combinations involve impermissible hindsight reconstruction of the invention involving "picking and choosing" from the teachings of that art. "Care must be taken to avoid hindsight reconstruction by using the application as a guide through the maze of prior art references combining the right references in the right way so as to achieve the result of the claims in suit."

Grain Processing Corp. v. American Maize-Products Co., 840 F.2d 902, 907 (Fed. Cir. 1988).

In addition to the arguments set forth above with respect to Romesburg, Fujii and Kim and Efron, Oh fails to teach the equation presented in claim 13, contrary to the Examiner's assertion. Applicants assert that the equation disclosed in claim 13 contains a specific waiting matrix which is not present in the Oh equation, as evidenced by comparison of the two. Further, the shortcomings of Romesburg, Fujii, and Kim and Efron, as set forth in detail above, are in no way overcome by the disclosures of Oh. Thus, applicants respectfully submit that the invention recited by claim 13 is not rendered obvious by the Examiner's proposed combination of Romesburg, Fujii, Kim and Efron, and Oh, and applicants respectfully request withdrawal of that rejection.

The Examiner has rejected claim 14 as anticipated by Romesburg. Applicants respectfully traverse that rejection. Applicants respectfully submit that Romesburg neither teaches nor suggests applicants' invention as recited. In the present application, claim 14 depends from claim 13. Consequently, the rejection of claim 14 should be withdrawn by the Examiner because claim 14 depends from an allowable claim. Applicants thus respectfully submit that their invention, as recited by claim 14, is patentably distinguishable over Romesburg. Thus, applicants respectfully submit that Romesburg neither teaches nor suggests the present invention as recited by claim 14.

Applicants thus respectfully submit that the instant invention, as recited by claim 14, is patentably distinguishable over Romesburg. Applicants further respectfully submit that the invention recited by claim 14 is not anticipated by Romesburg, as that reference fails to teach or suggest each element recited by those claims, as is required of a proper 35 U.S.C. § 102(e) reference. See, e.g., MPEP § 706.02. Finally, applicants respectfully submit that the Examiner's rejection of claim 14 as anticipated by Romesburg is no longer tenable, and respectfully request withdrawal of that rejection. Applicants further respectfully submit that the invention recited by claim 14 is not rendered obvious by any proposed hypothetical combination of Romesburg and any other prior art of record or with the knowledge of a person of ordinary skill in the art.

The Examiner has rejected claim 15 under 35 U.S.C. 103(a) as being unpatentable over Romesburg in view of Oh, Linebarger, Priest, and Raghothaman ("A Fast Affine Projection Algorithm for an Acoustic Echo Canceller using a Fixed-Point DSP Processor," ICASSP IEEE Int. Conf. Acoustics, Speech, and Signal Processing, 1997, pp. 4121-4124), further in view of Fujii and further in view of Kim and Efron. Applicants respectfully traverse that rejection. In the first instance, there is no teaching or suggestion in the references to make the hypothetical combination proposed by the Examiner, and thus the combination is improper. Applicants further respectfully traverse the cited hypothetical combination of references on grounds that these combinations involve impermissible hindsight reconstruction of the invention involving "picking and choosing" from the teachings of that art. "Care must be taken to avoid hindsight reconstruction by using the application as a guide through the maze of prior art references combining the right references in the right way so as to achieve the result of the claims in suit." Grain Processing Corp. v. American Maize-Products Co., 840 F.2d 902, 907 (Fed. Cir. 1988).

In addition to the arguments set forth above with respect to Romesburg, Fujii and Kim and Efron, applicants reassert that Oh fails to teach the equation presented in claim 15, contrary to the Examiner's assertion. Applicants assert that the equation disclosed in claim 15 contains a specific waiting matrix which is not present in the Oh equation, as evidenced by comparison of the two. Further, the shortcomings of Romesburg, Fujii, and Kim and Efron, as set forth in detail above, are in no way overcome by the disclosure of Oh. Thus, applicants respectfully submit that the invention recited by claim 15 is not rendered obvious by the Examiner's proposed combination of Romesburg, Fujii, Kim and Efron, and Oh, and applicants respectfully request withdrawal of that rejection.

The Examiner has rejected claim 16 as anticipated by Romesburg. Applicants respectfully traverse that rejection. Applicants respectfully submit that Romesburg neither teaches nor suggests Applicants' invention as recited. In the present application, claim 16 depends from claim 15. Consequently, the rejection of claim 16 should be withdrawn by the Examiner because claim 16 depends from an allowable claim. Thus, applicants respectfully submit that Romesburg neither teaches nor suggests the present invention as recited by claim 16.

Applicants thus respectfully submit that the instant invention, as recited by claim 16, is patentably distinguishable over Romesburg. Applicants further respectfully submit that the invention recited by claim 16 is not anticipated by Romesburg, as that reference fails to teach or suggest each element recited by those claims, as is required of a proper 35 U.S.C. § 102(e) reference. See, e.g., MPEP § 706.02. Finally, applicants respectfully submit that the Examiner's rejection of claim 16 as anticipated by Romesburg is no longer tenable, and respectfully request withdrawal of that rejection. Applicants further respectfully submit that the invention recited by

claim 16 is not rendered obvious by any proposed hypothetical combination of Romesburg and any other prior art of record or with the knowledge of a person of ordinary skill in the art.

Applicants have considered the prior art of record, and respectfully submit that none of the references relied upon by the Examiner in rejecting the claims of the present application, considered alone or in any hypothetical combination (between and among each other or with the knowledge of a person of ordinary skill in the art), teach or suggest Applicants' invention, as recited by the claims of the present application.

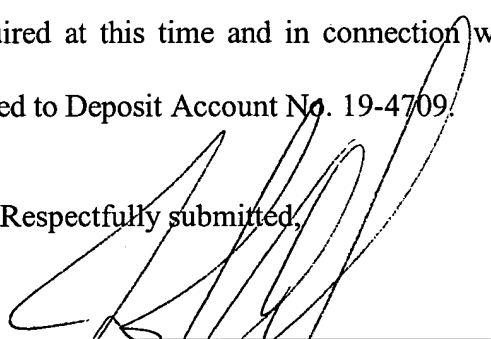
Applicants respectfully request reconsideration of the present application in view of the amendments to the specification and the claims as well as in light of the remarks provided herein.

Pages 19-21 of this Amendment, titled VERSION SHOWING CHANGES MADE TO THE SPECIFICATION AND CLAIMS, indicate the changes made to the specification and to the claims in accordance with this Amendment.

Early and favorable consideration of the present application in view of the amendments to the claims and remarks provided herein is respectfully requested. If the Examiner is not in a position to allow all claims as presently amended, the Examiner is urged to call the undersigned attorney at 212-806-5400.

Any additional fees or charges required at this time and in connection with the present application are hereby authorized to be charged to Deposit Account No. 19-4709.

Respectfully submitted,



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**VERSION SHOWING CHANGES MADE TO THE SPECIFICATION AND CLAIMS**

**IN THE SPECIFICATION:**

Please replace the paragraph beginning at page 24, line 10 with the following rewritten paragraph:

The price paid for robustness ~~a-ainst~~against double-talk is slower reconvergence after abrupt hybrid changes which can be seen in FIG. 11. The difference between PNLMS++ and R-~~PNLMS++~~R-PNLMS++ can be made fairly small, FIG. 11b. R-PNLMS++ performs better than NLMS in cases A and B for both parameter settings but is somewhat slower for case C. The performance loss for re-convergence of the robust algorithm is minor. FIGS. 12 and 13 summarize the divergence and convergence time of the algorithms where divergence/convergence time is defined as the time it takes for the algorithm to increase/decrease misalignment by 20 dB.

**IN THE CLAIMS:**

Please substitute claims 7-10, 13 and 15 as provided below, for claims 7-10, 13 and 15 currently in the present application.

7. (Amended) The filter of claim 3, wherein the adaptive scaled non-linearity is given by the formula:

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign } \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean error}$$

divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

8. (Amended) The filter of claim 4, wherein the adaptive scaled non-linearity is given by



$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign} \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean error}$$

divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

9. (Amended) The filter of claim 5, wherein the adaptive scaled non-linearity is given by

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign} \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean error}$$

divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

10. (Amended) The filter of claim 6, wherein the adaptive scaled non-linearity is given by

$$\Psi\left(\frac{|e_n|}{s}\right) \text{sign} \{e_n\} s_n, \text{ wherein } \Psi \text{ is a hard limiter; and } \left(\frac{|e_n|}{s}\right) \text{ is the mean error}$$

divided by a scale factor; and  $\{e_n\}$  is a sample of echo signal; and  $s_n$  is a scale factor.

13. (Amended) A robust echo canceller comprising:

an adaptive filter for outputting an error signal in response to a detected echo signal; and

means for supplying adaptive filter coefficients to said filter, wherein said filter

coefficients are given by  $h_{n+1} = h_n + \frac{\mu}{x_n^T G_n x_n + \delta} G_n x_n \varphi(|e_n| \text{sign}\{e_n\})$ , wherein  $h_n$  is the

estimated echo path;  $\mu$  is the overall step size parameter;  $G_n$  is the excitation matrix;

$x_n$  is the excitation vector;  $\delta$  is the regularization parameter that prevents division

by zero;  $|e_n|$  is the mean error; and  $\{e_n\}$  is a sample of echo signal.

15. (Amended) A robust echo canceller comprising:

an adaptive filter for outputting an error signal in response to a detected echo signal; and

means for supplying adaptive filter coefficients to said filter, wherein said filter coefficients are given by  $h_{n+1} = h_n + \mu G_n X_n R_{xx}^{-1}(n) [\varphi(|e_n|) \odot \text{sign}(e_n)]$ , wherein  $h_n$  is the estimated echo path;  $\mu$  is the overall step size parameter;  $G_n$  is the excitation matrix;  $X_n$  is the excitation matrix;  $R_{xx}^{-1}$  is the correlation matrix;  $|e_n|$  is the mean error;  $\odot$  denotes elementwise multiplications; and  $\{e_n\}$  is a sample of echo signal.